CNLS Publications 1981-1999: A Statistical Study

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Elementary statistical analysis is applied to all 1232 publications of the Center for Nonlinear Studies at Los Alamos National Laboratory. The Center's publication and citation record compares well with the three major nonlinear centers in the US. This study shows that the overwhelming majority of the Center's publications appear in Physics Journals. A citation study of publications in a given year shows that while publications during the first three years (1981-1983) had an exceptional impact, the following 14 years (1984-1997) are marked by steady quality.

On the occasion of the Center for Nonlinear Studies 20th anniversary, I surveyed the Center's publication record. For comparison purposes, three major nonlinear research centers in the US: Texas, San Diego, and Duke, were examined as well. This brief report attempts to answer the questions How many? How good? Where? i.e, How many publications? How well are they cited? Where are they published?

LANL library's SciSearch publication and citation database was used in the survey. In what follows, publications are defined as publications in journals covered by this database. Over 98% of the publications are regular articles and letters in refereed journals. The remaining 2% include reviews, comments, replies, and errata. CNLS publications are defined to be the subset containing either *Nonlinear* or *CNLS* in addition to *Los Alamos* in the authors' affiliation. In the Theoretical Division, and other Divisions of LANL, scientists who "feel part of the CNLS" usually list *Center for Nonlinear Studies* in their affiliation.

I. PUBLICATIONS (HOW MANY?)

The CNLS has published 1232 papers since 1981. During the first 7 years, the number of publications grew linearly. In the late 80's the Center's activity plateaued at around 70 publications per year. Work performed at the Center during the first 3-4 years was seminal. It created and defined what is now the mature field of "Nonlinear Science". A Nonlinear Optics Institute at Warsaw University in Poland was the first nonlinear institute. In the US, the University of California at San Diego established a nonlinear center one year earlier than CNLS. Since the early eighties, many more institutes and centers were established around the world. Interestingly, the early growth rate in activity in the CNLS parallels the growth rate in worldwide publications by nonlinear institutes and centers (see Fig. 1). The latter number is still growing faster than linearly. Many universities now have nonlinear components in a wide spectrum of sciences.

We compared CNLS with three closely related and well-defined nonlinear centers in the US, the Institute for Nonlinear Studies (INLS) at the University of California at San Diego, the Center for Nonlinear Dynamics (CNLD) at the University of Texas-Austin, and the Center for Nonlinear and Complex Systems (CNCS) at Duke University. As will be shown later, these centers are active in the same areas as the CNLS: Dynamical Systems, Pattern Formation, Statistical Mechanics, Chaos, Solitons, Materials, and Fluids. Moreover, Texas is ranked first, and San Diego seventh, in the US News and World Report ranking of Ph.D. programs in Physics with a specialty in Nonlinear Dynamics/Chaos (see Table I). Texas and Duke have a larger experimental component, while San Diego and the CNLS have a larger theoretical emphasis. As shown in Figure 2, the publication patterns are similar: an initial linear growth and then, a plateau. Most notably, the CNLS activity is comparable with the aggregate of the three. The CNLS has 1232 publications, while the 3 centers combined have 1069 publications. Hence, in addition to individual statistics, we also present the aggregate of the 3 Nonlinear Centers (3NC). There is a small overlap between the publication sets. The CNLS has 20, 9, and 2 joint publications with San Diego, Texas, and Duke, respectively, resulting from collaborations as well as personnel exchanges between these institutions. Interestingly, 5% of CNLS publications use the abbreviation *CNLS* rather than *Center for Nonlinear Studies* as the affiliation, while none of the other 3 nonlinear centers use abbreviations. This fraction has risen to 17% in the past 3 years, reflecting the CNLS strong name recognition.

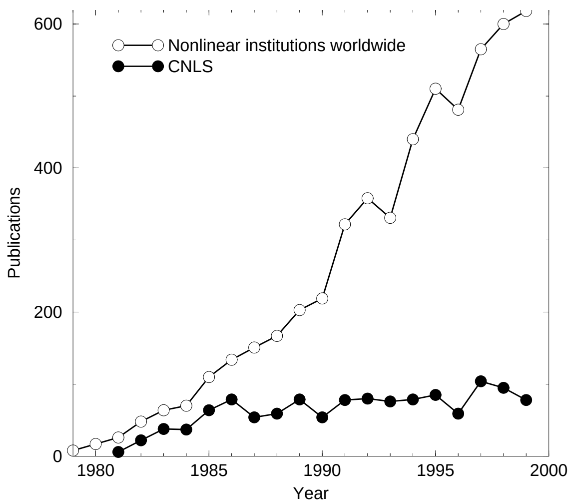

FIG. 1. Publications per year: CNLS versus worldwide publications by Nonlinear Centers and Institutes.

Rank	School	Rank	School
1	Maryland	7	MIT
1	Texas	7	UC, San Diego
3	Chicago	7	Illinois
3	Cornell	10	Princeton
5	UC, Santa Barbara	10	UC, Berkeley
5	Georgia Tech		

TABLE I. US News & 1999 World Report ranking of Physics Ph. D programs with a specialty in Nonlinear Dynamics/Chaos.

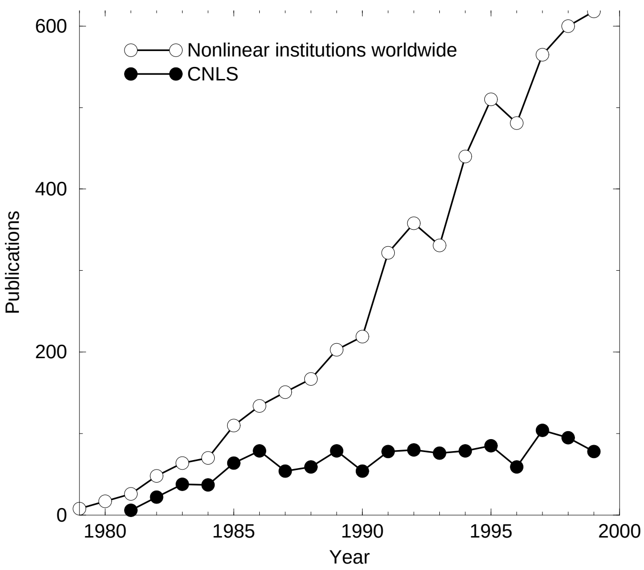

FIG. 2. CNLS publications by year, compared with the total number of publications by 3 nonlinear centers in the US.

II. CITATIONS (HOW GOOD?)

Citation count is a useful measure for evaluating the impact of a scientific works. For example, it is a factor in tenure decisions. We compared the citation distribution of CNLS publications with that of the Institute for Scientific Information database (ISI) which covers all fields of science. Of all the 780,000 publications in the ISI database only 53% (!!!) were cited at least once, 14% were cited >10 times, and only 1% were cited >100 times. The CNLS corresponding percentages are significantly larger: 85%, 55%, and 3.5%. Remarkably, despite the relatively small number of publications, the CNLS citation distribution has the same shape as the ISI distribution (See Fig. 3). However, it is significantly higher, reflecting the average citation count of 16, double that of the ISI.

Table II compares the CNLS with the 3 centers both individually, and combined. Over a comparable period of time, the CNLS number of publications, and total number of citations is almost identical with that of the 3NC. The CNLS has a significant edge in high impact publications, an edge in publications in the Physical Review Letters, while the 3 centers have an edge in publications in Nature and Science. These statistics are consistent with the US News ranking. Despite its compact size, Texas stands out in quality and impact, while San Diego has a solid and consistent presence. The CNLS numbers are quite impressive, and they show that it is a unique Center whose impact is as deep as it is wide.

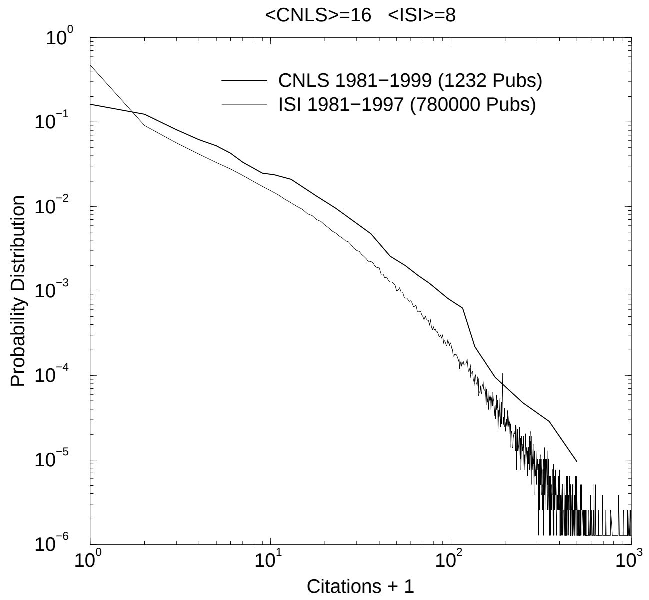

FIG. 3. The probability distribution of citations, i.e., the probability that a paper is cited a given number of times. The number of citations was shifted by 1. The data is compared with the Institute of Scientific Information database which contains 780,000 publications.

	CNLS	3NC	UCSD	Texas	Duke
Publications	1232	1069	663	320	86
Years	19	18	21	15	12
Pub/Year	64	59	32	23	7
Citations	20000	17000	10000	6000	1000
Cit/Pub	16	16	15	19	12
100+ citations	42	22	13	8	1
#1	630	560	560	200	110
#2	610	330	330	180	60
#3	400	310	310	150	50
PRL	146	112	51	49	12
Nature & Science	10	25	8	14	3
Faculty/Staff	30	20	10	5	5
Postdocs	25	25	10	5	5
Grad students	5	60	20	25	15
Long term visitors	5	3	1	1	1
Staff	4	4	1	2	1

TABLE II. CNLS versus 3 combined nonlinear centers (3NC): publications, citations, high profile publications, and personnel.

To examine to quality of the publications, we studied the impact of publications by year. Specifically, the average citation count in the following two years was measured for all papers published in a given year. Therefore, 1998, and 1999 are excluded. Publications during the first 3 years 1981-1984 stand out in their exceptionally high impact (see Fig. 4). Nevertheless, the following years are marked by a sustained quality with an impact factor of roughly 5. This is remarkable, given the significant growth in the total number of publications per year (see Fig. 1). Overall number of citations for publications from the eighties suggest that the expected number of citations a paper will gain is roughly 5 times the impact. Therefore, the average number of citations of the current cnls publications should eventually reach 25, and the total citation count of all 1232 publications should reach roughly 30,000.

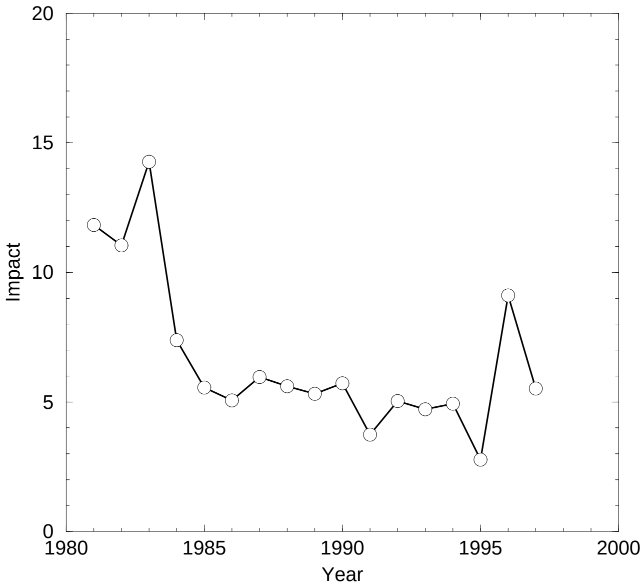

FIG. 4. Impact of publications in a given year. Impact is defined as the average number of times a paper is cited in the two years following the publication date.

III. JOURNALS (WHERE?)

In the above it was implicitly assumed that research performed in the CNLS has significant overlap with the three nonlinear centers. This is indeed the case. A very obvious question, in what journals does the center publish? is the relevant one here. As seen from Table III, modulo minor differences (CNLS has strong presence in condensed matter physics, while both Texas and San Diego have strong presence in Chemical Physics), all the nonlinear centers publish in similar journals. The similarity is striking as the overwhelming majority of the articles are published in Physics journals. In fact it is even difficult to identify other significant disciplines. Roughly 90% of the publications are published in Physics journals! The rest are distributed among Biology, Mathematics, and Earth Sciences (or more likely, Biological Physics, Mathematical Physics, and Geophysics).

CNLS has published in over 150 different journals, yet 56% of the publications appeared in the following 6 journals *Phys. Rev. A*, *Phys. Rev. B*, *Phys. Rev. E*, *Phys. Rev. Lett.*, *Physica D*, and *Phys. Lett. A*. This picture is even more striking when one looks at the most cited publications; the top 5 publications, and all but one of the top 15 publications appeared in the 6 aforementioned journals. Moreover of the 42 100+ citation papers, only two appeared in non-Physics journals (Nonlinearity and Science). The readership of these 6 journals is surely well aware of the scientific contributions of the CNLS. In other fields, the CNLS has had a negligible impact. There are 70+ journals in which the CNLS has published only once.

A look at the journal list shows hints of several diversification efforts. It is hard to point out a critical mass in any of these areas, and a logical conclusion is that such endeavors have not reached a critical mass of excellence. In fairness, one must add that it is too early to judge the most recent efforts.

Journal	CNLS	3NC
Physica D	150	53
Phys. Rev. Lett.	146	112
Phys. Rev. B	132	21
Phys. Lett. A	98	49
Phys. Rev. E	96	117
Phys. Rev. A	69	114
Phys. of Fluids	42	30
Synth. Metals	33	5
J. Stat. Phys.	31	32
J. Math. Phys.	22	8
J. Phys A	18	13
Physica B & C	12	0
J. Phys. C	11	3
Phys. Rev. D	10	0
J Comp. Phys.	10	0
Nonlinearity	9	0
Proc. Nat. Acad.	8	1
J Chem. Phys.	6	56
J. Fluid Mech.	10	49
J. Phys. Chem.	2	38
Nature	6	18
Physica A	10	15
Europhys. Lett.	5	14
J. Geophys. Res.	2	12
J. Luminescence	1	11
Int J. Bif. Chaos	1	10
Chaos	2	9
Science	4	6

Table III. CNLS versus 3NC: publications by journal. The complete CNLS list is given in an appendix.

IV. CONCLUSIONS

The above statistics show that the CNLS has a very distinguished publication history. The activity level rose linearly during the first 5 years and then it reached a steady level. While the quality of the publications was exceptionally high during the first 3 years, it has maintained a steady level during the following 14 years. This is remarkable, given the overall increased level of activity. Clearly, the CNLS has a strong presence in an important field it is largely responsible for creating.

Most scientists currently involved with the CNLS may not be fully aware of the magnitude of the center's impact. What surprised me is the fact that 90% of CNLS publications appeared in Physics journals. I informally polled three staff members involved with the CNLS (including two former center deputy leaders), and they estimated this percentage to be 33%, 33%, and 75%. Surely, the 90% figure reflects the nature of LANL, primarily a Physics lab, but nevertheless this statistics is very meaningful.

I would like to thank G. D. Doolen, D. D. Holm, and T. C. Wallstrom for useful comments.

APPENDIX A: CNLS PUBLICATIONS BY JOURNAL

Physica D	150
Phys Rev Lett	146
Phys Rev B	132
Phys Lett A	98
Phys Rev E	96
Phys Rev A	69
Phys of Fluids	42
Synth Metals	33
J Stat Phys	31
J Math Phys	22
J Phys A	18
Physica B & C	12
J Phys C	11
Phys Rev D	11
J Comp Phys	10
J Fluid mech	10
Nonlinearity	10
Physica A	10
Proc Nat Acd Sci	8
J App Phys	7
J Chem Phys	7
Int J mod Phys B	6
J Phys Cond Mat	6
Math Biosci	6
Nature	6
Astrophys J	5
Biophys Jour	5
Comm Math Phys	5
Comp Rend Acad Sci	5
Europhys Lett	5
Nuovo Cimento	5
Physica Scripta	5
Zeit fur Phys B	5
App Num Math	4
J Magnetism	4
J Phys Soc Jap	4
J Theo Bio	4
Lett Nuovo Cimm	4
Mol crys Lqd Crys	4
Science	4
Phys Rep	4
SIAM J App Math	4
SIAM J Num Anal	4
Ann NY Acad Sci	3
J De Physique	3
J Phys Chem Solid	3
J Plasma Phys	3
J Opt Soc	3
SIAM J SciStatComp	3
SIAM J Math Anal	3
Adv App Math	2
AIDS	2
Am J Phys	2
Astrnm & astrphys	2
Biosys	2
Comm Diff Eq	2
Comp Math	2
Faraday Disc	2
IEEE fuzzy sys	2
Int J Mltphse Flow	2
J De Physique II	2
J Comp App Math	2
J Geophys Res	2
J Math Bio	2
J Mod Opt	2
J Mol Liquids	2
J Phys Chem	2
Lect Notes Math	2
Lett Math Phys	2
Math Comp Model	2
Mech Res Comm	2
Nature Struc Bio	2
Nonlin Anal	2
Nuc Instruments	2
Nuc Phys B	2
Opt Mat	2
Opt Lett	2
Phyl Trans Roy Soc	2
Proc Roy Soc Lond	2
Phys Lett B	2
SIAM Rev	2
Acta Mech Sin	1
Aiaa J	1
Aiche J	1
Amm Sci	1
Ann der Phys	1
Ann henri poin	1
Ann rev Fluid Mech	1
App Math Comp	1
App Opt	1
App Phys Lett	1
Biochem Cell Bio	1

Bio Cyber	1
Bull Math Bio	1
Chaos	1
Chem Eng Sci	1
Chem Phys lett	1
Comm Acm	1
Comp Geosci	1
Computer	1
Comp Chem Eng	1
Comp Fluid	1
Dynam Stab Sys	1
Euro J Mech B	1
Eur J op res	1
Eur Phys J B	1
Found Phys	1
Gastroenterology	1
Geo Mag	1
Hadronic J	1
ICAA J	1
IEEE App Supercond	1
Ima App Math	1
Int J Bif Chaos	1
Int J Eng Sci	1
Int J Mod Phys C	1
Int J Theo Phys	1
Jetp Lett	1
J de Math et App	1
J Comp Bio	1
J Elasticity	1
J Eng Mech	1
J Fluid Eng	1
J Func Anal	1
J Immun	1
J Low temp Phys	1
J Lumin	1
J Mater Res	1
J Math anal	1
J Mol Bio	1
J Mol Evol	1
J Nonlin Sci	1
J Petrol sci	1
J Phys Ocean	1
J Virol	1
Kvatnov Elektr	1
Lect Not Phys	1
Lett Math Phys	1
Math Proc Camb	1
Math Comp Simul	1
Math Comp	1
Mathematika	1
Microel Eng	1
Num Alg	1
Phyl Mag	1
Phys Rev C	1
Rev Mod Phys	1
Prog Theo Phys	1
Solid State Comm	1